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THE RELATIONSHIP BETWEEN BIOLOGICAL/ENVIRONMENTAL FACTORS AND SENSORIMOTOR AND LANGUAGE DEVELOPMENT OF PRETERM INFANTS AT PRESCHOOL AGE

BY

CARLA SOARES ATTANASIO

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

DEPARTMENT OF OCCUPATIONAL THERAPY

EDMONTON, ALBERTA

SPRING, 1991

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ENTITLED **THE RELATIONSHIP BETWEEN BIOLOGICAL/ENVIRONMENTAL FACTORS AND SENSORIMOTOR AND LANGUAGE DEVELOPMENT OF PRETERM INFANTS AT PRESCHOOL AGE**

SUBMITTED BY **CARLA SOARES ATTANASIO**

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF **MASTER OF SCIENCE**

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ABSTRACT

This study examined the relationship of gestational age and maternal education, and the sensory, motor, and language development (as measured by the Miller Assessment for Preschoolers) of premature infants at 4 years of age.

The sample consisted of 24 preterm children who had been diagnosed as neurologically normal at 18 months of age. Maternal education and gestational age information was obtained for each child. The Miller Assessment for Preschoolers (MAP) was administered when the child was 4 years of age (M age = 4.6). The children were scored on five MAP performance indices (Foundations, Coordination, Verbal, Non-Verbal and Complex Task indices) and the total score was determined.

Maternal education and gestational age did not explain a significant amount of the variation in any performance index and the total score when using multiple regression analysis. Gestational age alone as a continuous variable was significantly correlated with the Non-Verbal index. When two gestational age groups (<32 weeks; 32-36 weeks) were compared on the performance indices and total score, the observed frequencies on the Foundation index differed significantly from the expected frequencies. Maternal education was not significantly related to any of the dependent measures. The significance of these findings for occupational therapists is discussed.

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CHAPTER II

INTRODUCTION

Within the last twenty years, significant advances in perinatal care have resulted in an improved survival rate for preterm infants less than 37 weeks gestational age (Scott, 1987). A major concern persists, however, regarding the long term prospects of these children. Follow-up studies investigating the outcome of preterm children show that 25 to 64% of these children present neurodevelopmental deficits or learning problems at 3 to 10 years of age (Calame et al., 1986; Hunt, Tooley, & Harvin, 1982; Nickel, Bennett, & Lamson, 1982; Vohr, Coll, & Oh, 1988). In particular, studies that examined the relationship of neurological status of the preterm infant in the first two years of life and their later developmental outcome revealed that, although the majority of these infants were classified as neurologically abnormal and suspicious, a significant percentage (14 - 40%) of the infants who were delayed had been classified as neurologically normal (Stewart et al., 1989; Vohr et al., 1988). These findings raise the question of why some apparently neurologically normal preterm infants develop well while others do not. Authors who have investigated the outcome of the normal preterm babies (Drillien, 1972; Stewart et al., 1989; Vohr et al., 1988) reported that factors such as social environment and younger gestational age may play a role in the development of these babies, a position supported in other reports (Largo et al., 1989; Sameroff, 1986; Siegel, 1982; Smith, Somner, & Tetzchner, 1982; Zubrick, Macartney, & Stanley, 1988). In fact, younger gestational age associated with low birth weight (LBW) has been shown to have a significant correlation with developmental outcome of preterm infants (Largo et al., 1989; Zubrick et al., 1988).

The objective of this study was to investigate how preterm infants who were diagnosed neurologically normal at 18 months were performing on a measure of sensory, motor, language and behavioral development at four years of age. As well, this project also investigated the possible influences of gestational age and maternal education on the performance areas mentioned above. This age for assessment was chosen because, according to Drillien (1972), three years old is the "minimum age for making a reasonably confident assessment about handicaps other than severe physical, mental and neurological defects" (p.564). Thus, reliable assessment of developmental status should be possible by four years of age. As there is a high percentage of normal

preterm infants showing developmental problems at later ages, the study of these children has become important. The detection of possible problems before school age could prevent the adverse consequences associated with late identification of deficits. According to Miller (1982), the consequences of late identification include emotional problems associated with school failure and reduced effectiveness of therapeutic treatment at later ages. Moreover, preschool motor, perceptual-motor, and cognitive abilities are reported to predict school performance (Sell, Gain, Gluckman, & Williams, 1985; Solan & Mozlin, 1986). Thus, early identification of deficits in these areas could be of great benefit for these children and have implications for the practice of occupational therapy.

Objectives

A. General Objective:

1. Evaluate the performance of preterm infants (diagnosed neurologically normal at 18 months) at 4 years of age on the MAP.

B. Specific Objectives:

1. Evaluate the relationship of gestational age to the five indices of performance and the total score of the MAP at 4 years of age;

2. Evaluate the relationship of maternal education to the five indices of performance and the total score of the MAP at 4 years of age.

Definitions of Terms:

1. Neurologically normal: For the purpose of this study, "neurologically normal" was used to describe preterm infants who have no known neurological deficits at 18 months of age. It is recognized that there may be neurological deficits but our instruments may not be sensitive enough to detect them.

2. Low birthweight: Infants whose weight at birth was below or equal to 2,500 grams.

CHAPTER II

LITERATURE REVIEW

Early Development of Preterm Infants

The premature infant (< 37 weeks gestational age) provides an unique opportunity to investigate neurophysiological and behavioral development in its early stages. In addition, the study of these functions also provides better understanding of the "normal" development of the preterm infant, who accounts for 7 to 10% of all live births in the United States (Gorski, 1984).

Several authors have investigated developmental characteristics of the preterm baby (Dargassies, 1966; Ferrari, Grosoli, Fontana & Cavazzuti, 1983; Howard, Parmelee, Kopp, & Littman, 1976; Palmer, Dubowitz, Verghote, & Dubowitz, 1982; Piper, Kunos, Willis, & Mazer, 1985). These studies have shown that premature infants have significant differences in neurological and behavioral development at 40 weeks gestational age (GA) when compared to full-term infants. However, studies of subsequent motor, neurobehavioral, and neurological development of preterm infants during the first two years of life provide inconclusive results. Palisano (1986) found no significant differences between preterm and fullterm infants in gross and fine motor function at 12, 15 and 18 months corrected age, contrary to Forslund and Bjerre (1985) who found significant differences in both functions at 9 and 18 months of age. Ungerer and Sigman (1983) reported that at 13.5 months no difference in fine motor function was found between preterm and fullterm groups; however, the preterm infants were performing at lower levels in the area of gross motor function.

The differences between the results of these studies do not seem to be explained by birth weight or gestational age. Palisano (1986), who reported no significant differences between preterm and fullterm infants, had a preterm sample ranging from 29 to 32 weeks GA and weighing < 2500 grams. On the other hand, Forslund and Bjerre (1985) who found significant differences, had a preterm sample with a wider range of age (27 to 34 weeks GA) and heavier infants (< 3200 grams). Interestingly, the results may be associated with the medical and neurological status of these infants. In Palisano's study, the sample included only healthy preterm infants, while in the other studies (Forslund & Bjerre, 1985; Ungerer & Sigman, 1983), the sample contained both healthy and sick preterm infants.

Some authors (Forslund & Bjerre, 1985; Gorga, Stern & Ross, 1985; Gorga,

Stern, Ross, & Nagler, 1988) have measured primitive reflexes in preterm babies as a means of assessing the maturation of the central nervous system. Gorga et al. (1985) found that, at 3 and 6 months corrected age, the fullterm group (n = 15) was more mature than the two groups of healthy (n = 38) and sick (n = 97) preterm infants in the area of reflex responses and inhibition. However, in another report by Gorga et al. (1988) using a smaller sample, there were no significant differences between healthy preterm (n = 12) and fullterm infants (n = 12) during the first year of life. Forslund and Bjerre (1985) found significant differences between fullterm and sick preterm groups in balance and righting reactions at 9 months. However, no significant differences were reported in dorsiflexion footsole, palmar grasp, moro, and plantar grasp reflex. The contradictory findings between Gorga et al. studies seem to be attributable to differences in some inclusion criteria in the second study (Gorga et al.,1988) and a smaller sample size with more equal groups. Another possible explanation for the differences among the three studies mentioned above (Gorga et al., 1985, 1988; Forslund & Bjerre, 1985) might be that Forslund and Bjerrer (1985) used different measurement instruments from the Gorga et al. studies.

Divergent findings are also reported for preterm infants in the neuromotor behavioral area. Gorga and associates (1985) found similar patterns of development between fullterm and healthy preterm infants on the following examinations during the first year: head control, development of upper extremities, and sitting. Differences in the two groups were reported in muscle tone and standing and walking measures. Although Gorga and colleagues (1985) report some similar findings in a later study (Gorga et al., 1988), the results relating to muscle tone and sitting measures during the first year were different. Forslund & Bjerre (1985) also examined aspects of neuromotor behavior. The authors found no significant differences between fullterm and sick preterm groups in muscle tone and walking measures, contradicting the Gorga et al. study (1985).

Results of these studies are inconclusive and do not permit us to trace a sequence of development for these premature babies. Piper et al. (1985) clearly expressed the present state of preterm infant research:

> Until more information on the ontogeny of neurological development [of the preterm babies] becomes available and the long-term outcome of these infants is known, the predictive value of these neonatal differences may be debated. While the neurological functioning of healthy preterm infants clearly is different from that of normal fullterm infants, it is difficult to say whether this difference is

indicative of delay or merely represents a variation in the pattern of neurological development (Piper et al., 1985, p. 603).

Later Development of Preterm Infants

Several studies have investigated the long term outcome of preterm children (Calame et al., 1986; Largo et al., 1989, 1990; O'Mara & Johnston, 1989; Rubin, Rosenblatt, & Balow, 1973; Siegel et al., 1982; Ungerer & Sigman, 1983; Zubrick et al., 1988) and found that many of the children have neurodevelopmental or learning problems. In general, preterm infants have significantly lower scores than fullterms on a wide range of measures. However, the findings among the studies are not consistent.

Vohr et al. (1988) found that preterm infants at 2 years chronological age were significantly delayed in language ability compared to fullterms. This finding is supported by Calame et al. (1986) and Michelsson, Lindahl, Parre, and Helenius (1984) who conducted studies with 8 and 9 year-old children, respectively. However, Siegel et al. (1982) did not find any significant difference in verbal performance on the Reynell Developmental Language Scale between the preterm and fullterm group at 2 years corrected age. It is possible that differences in the results of these studies could be related to the inconsistent use of age correction for prematurity. As this is an important procedure when comparing young preterm and fullterm infants (Ungerer & Sigman, 1983), the Siegel and associates study (1982) may provide more reliable results than the Vohr et al. study. It may be possible that differences in language development only appear at later ages (see Calame et al., 1986; Michelsson et al., 1984), when more complex linguistic structures are required.

Regarding visual-motor development, Calame et al. (1986) reported that preterm infants had significantly lower scores than fullterm infants. Although this result is supported by other studies (Klein, Hack, & Breslau, 1989; Ungerer & Sigman, 1983), McDonald, Sigman, and Ungerer (1989) did not find any significant difference between the two groups in visual-motor measures at five years of age. As this study is a follow up of Ungerer and Sigman's (1983), it is possible that divergent findings on these reports are attributable to the fact that different measurement instruments were used in the initial and follow-up study.

More consistent results were found in the motor area. Several authors (Calame et al., 1986; Klein et al., 1989; Michelsson et al., 1984, & Siegel, 1982) reported that preterm infants score significantly lower than fullterm infants in fine and gross motor

abilities at 5 to 9 years.

Regarding behavioral development, Walker (1989) and McDonald et al. (1989) found that preterm infants presented more behavioral problems, such as temper tantrums and dependence, than did fullterm children. This finding was not supported by O'Mara and Johnston (1989). However, the latter authors used only the Behavioral Screening Questionnaire for measuring behavior which they felt was not sensitive enough to evaluate characteristics such as irritability, attention span, and restlessness.

Thus, although preterm infants are reported as more developmentally delayed than fullterm infants, agreement concerning the abilities affected has not been reached except in the motor area. The contradictory findings in these studies seem to be attributable to different methodological procedures, such as different measurement instruments, different age at the time of evaluation, and presence of different medical abnormalities. According to Scott (1987), adverse medical abnormalities have been correlated with different outcomes. Thus, this could be one of the major confounding variables when evaluating the child's outcome.

A few studies have investigated the outcome of neurologically normal preterm infants in order to reduce possible confounding variables (Drillien, 1972; Stewart et al., 1989; Vohr et al., 1988). However, only Vohr et al. (1988) provided a fullterm control group. In their study, they documented that preterm infants were significantly delayed in comparison with the fullterm group on language measures. Although Drillien (1972) and Stewart et al. (1989) did not include any control children born at term, they stated that 30% and 14.2%, respectively, of their normal preterm children presented deficits at 3 and 4 years of age, respectively, in the areas of neurological and cognitive development. Thus, some neurologically normal preterm infants are lagging behind normal development. However, no consensus has yet been found concerning the abilities affected.

Gestational Age

Preterm infants are frequently described as at risk due to the fact that they are born with immature systems. This condition is thought to be a threat to children's normal development. As the brain and body systems mature during the last two months of gestation, a change in environment from the uterus to special care nurseries may jeopardize motor, cognitive, emotional, and social functions (Short-DeGraff, 1988).

In general, preterm infants have significantly lower scores on language and

perceptuo-motor measures than fullterm children (Calame et al., 1986, Siegel, 1982, Ungerer & Sigman, 1983; Zubrick et al., 1988). Moreover, when considered as two separate groups, preterm infants who are less than 32 weeks GA at birth have less favorable scores in language, neurological, intellectual (Largo et al., 1989), school performance, attention, and social behavior (Grigoroiu-Serbanescu, 1984) than preterm infants born between 32 and 36 weeks GA. The question concerning these findings is if prematurity by itself is significantly correlated with outcome. In general, investigators have shown that gestational age in association with other factors, particularly LBW and socio-economic status (SES), are significantly correlated with academic performance, cognitive, language, and motor development (Kitchen et al., 1980; Siegel et al., 1982; Zubrick et al., 1988). When considering its effect independently of other variables, most studies report that prematurity alone appears to have no relationship with the abilities mentioned above (Cohen, Parmelee, Sigman, & Beckwith, 1988; Drillien et al., 1980; Rubin et al., 1973; Siegel, 1982). However, Largo et al. (1989) and Grigoroiu-Serbanescu (1984) who investigated the outcome of younger and older preterm infants, found that gestational age was predictive of outcome at 5 to 7 years. Thus, it seems that the independent effect of prematurity on later outcome is still controversial and may be more predictive when examined in groups of younger and older preterm infants at later stages of development.

When looking at the effects of gestational age on the development of preterm infants diagnosed neurologically normal, Vohr et al. (1988) found that gestational age made a significant independent contribution to language development at 2 years. However, Stewart et al. (1989) found that neurodevelopmental status at 1 year was a better predictor of the child's sensory and cognitive functions at 4 years than was gestational age. Differences in these studies seem to be attributable to methodological procedures such as different age at the time of the evaluation and use of different measurement instruments. As only a few studies have been done, the impact of gestational age on the development of normal preterm infants can not be adequately predicted at this time.

Most of the information is still inconclusive. Further investigation is needed in this area in order to determine the effect of prematurity on the later outcome of preterm children.

Maternal Education

In an attempt to examine the relationship between social environment and child development, maternal education has been frequently investigated in association with SES (Rickards et al., 1988; Sameroff, 1986; Siegel, 1982). According to Hunt (1986), "the environmental component of the parent education is conceptualized as an array of parenting styles that determines the physical and social environment of the infant and child" (p.45). As well, McGillicuddy-DeLisi (1982) reported that parents with higher education-income differed from parents with lower education-income in the manifestation of some characteristics such as positive feedback and awareness of the child's readiness for knowledge. Parush and Clark (1988) in their validation study of a sensory developmental questionnaire for mothers of newborns also found that "the more formal education a mother had had, the more knowledgeable she was concerning the sensory capacity of the newborn, and the more she perceived herself as influential over her child's development" (p.14).

Several studies have investigated the effects of mother's educational level on long-term outcome of preterm infants. Scott (1987), in a review of follow-up studies examining the effects of prematurity on later childhood, found that maternal education was a powerful predictor of infant IQ level. The same result, in association with SES, was reported by Sameroff (1986), Rickards et al. (1988) and Klein et al. (1985). Robertson et al. (1990), investigating the school performance of preterm LBW infants, found that maternal education was the primary predictor of reading, spelling, and arithmetic achievement. Additional studies (Blackman, Lindgren, Hein, & Harper, 1987; Siegel, 1982) investigating outcome of preterm infants at preschool age reported a significant correlation between low maternal education ($\underline{M}$ = 13.3; $\underline{SD}$ = 1.9) (Blackman et al., 1987) and perceptuo-motor and cognitive problems. Thus, it appears from these investigations that a low level of maternal education is associated mainly with cognitive deficits.

Although these studies are in agreement concerning the relationship of maternal education and outcome, they do not report the children's neurological status during the first year of life. Follow-up of neurologically normal preterm babies would provide more information about the effects of prematurity and environmental influences on the development of these children, eliminating some possible confounding variables related to medical abnormalities.

In summary, several studies support a strong relationship between maternal education and cognitive ability. However, as this delay in cognitive function may be

related to other unhealthy conditions during the first year, additional research with normal preterm babies would provide a better evaluation of the impact of this variable (maternal education) on the child's development. Separating maternal education and the influences of SES is difficult. However, an evaluation of SES goes beyond the scope of this project and should be investigated in future studies.

Conclusion

Based on the literature review, a series of conclusions can be drawn about preterm development. The developmental sequence of preterm infants is not clearly defined. Although preterm infants are different from fullterm infants in their developmental process, it is not clear if this difference represents a developmental problem or if it is a normal pattern of development for these immature infants.

Studies investigating the long term outcome of premature children report that differences between some preterm and fullterm infants are present at later years. However, there is no agreement concerning the specific abilities jeopardized. This may be due to differing methodological procedures between the studies such as the inclusion or exclusion of infants who present with medical abnormalities (e.g., low Apgar scores, respiratory problems, infections). Studies with normal preterm infants would eliminate one major confounding variable, neurologic abnormality, and provide a better understanding of the infants' development.

It is also possible that exposure to different risk factors may affect different developmental functions. Some authors mention that risk factors such as complications associated with prematurity itself and maternal education may play a role in the outcome of these infants. Although maternal education is significantly correlated with the infant's cognitive development, the significant association of prematurity with later outcome has yet to be confirmed. Some studies have reported the significant effect of gestational age in association with birth weight on later development. Thus, it might be possible that the variables of maternal education and gestational age can predict later outcome.

In conclusion, there is still much work to be done in the area of preterm infant development. Although it is not confirmed that preterm birth is associated with later problems, preterm infants without neurological problems are still showing deficits at later ages. The studies mentioned here presented possible factors, or group of factors, which can influence the outcome of these infants. Investigation of these factors may help us to understand the dynamic process of these infants' development.

Hypotheses

Based on the review of the literature, it is expected that:

1. Some preterm children will score below the normal range on the total score of the MAP at 4 years of age;

2. Gestational age will be predictive of the Verbal index of the MAP;

3. Maternal education at birth will be predictive of the Complex Task and Non-Verbal indices of the MAP;

4. Gestational age and maternal education will be predictive of the Complex Task, Coordination, Verbal and Non-Verbal indices of the MAP.

CHAPTER III

METHOD AND PROCEDURES

Introduction

The current project follows preterm children involved in an project entitled "Impact of preterm birth on the neuromotor development of the premature infants" (Piper, Byrne, Darrah, & Watt, 1989), conducted from 1985 to 1987. The project studied 75 preterm children from birth to 18 months of age.

Study Design

This was a historical cohort study. The sample was "identified from the past records and followed forward from that time up to the present" (Fletcher, Fletcher, & Wagner, 1988, p.99). This design provides information about the possible association between exposure to a risk factor and developmental outcome (Fletcher et al., 1988; Lilienfeld & Lilienfeld, 1980).

The variables considered in this study are:

-independent:

Gestational age - The specific gestational age as well as two groups of gestational age (<32 weeks GA; 32-36 weeks GA) will be considered for multiple regression analysis and chi-square analysis, respectively.

Maternal education - Number of years of education at present and two groups of maternal education (≤12 years of education; >12 years of education) will be used for multiple regression and chi-square analysis, respectively.

-dependent:

The total score and the five performance indices of the MAP: Foundations, Coordination, Verbal, Non-Verbal and Complex Task indices, which are described later in the measurement instrument section. The category scores are reported in percentiles.

Sample

The subjects of this study had been classified as premature infants (less than 37 weeks GA) and were cared for in the neonatal intensive care unit of the University of Alberta Hospital. Infants with congenital abnormalities were excluded. From the initial sample of infants in the Piper and associates (1989) study, 45 were identified as

neurologically normal at 18 months by a experienced pediatric neurologist who used the neurological examination of the Collaborative Perinatal Project (Hardy et al.,1979). From this group of 45 children, 24 were evaluated in the present study. Twenty-one children were not included due to age (too young or too old for the age range established for the project), having moved out of town, or not being available during the six month period of the study.

Eighteen of the 24 subjects in this project were also part of an ongoing study conducted by Lane and Holdgrafer (1990). The families of these children were contacted after the research assistant for the Piper et al. (1989) project obtained permission to release their names. The parents were sent a letter (see appendix A) explaining the study, as well as a consent form (see appendix B). Approximately one week later, parents were contacted in order to see if they had any questions and to explain the objectives of the studies. For the ones who were still interested in participating, an appointment for the child's evaluation was made. On the day of the evaluation, parents were free to ask any questions about the study and the consent form was signed.

The six subjects who were not part of the Lane and Holdgrafer study were recruited using the same procedure. A different consent form (see appendix C) and a letter explaining the purpose of the study were sent (see appendix D).

Data Collection

This study used the following data already collected from Piper et al. (1989) study :

1. Birth weight;
2. Gestational age: This information was collected through mother's report of the last menstrual period and confirmed by ultrasound or by the Dubowitz technique (Dubowitz , Dubowitz, & Goldberg, 1970);
3. Neurological examination of the collaborative perinatal project: This examination included a comprehensive neurological and developmental evaluation of the child at 18 months. The neurological evaluation included information about the child's reflexes and motor development. The medical evaluation provided information about child's health condition. This information was used to ensure that only neurologically normal children were included in the sample.

The present study collected the following additional information:

1. Maternal education (see appendix E) - This information was collected from the

mother on the day of the evaluation.

2. Performance of the children on the total score and the five performance indices of the MAP.

Training in the administration of the MAP was conducted to ensure that the instrument was used consistently. The same occupational therapist who collected the data for the two studies (the present one and Lane and Holdgrafer's study) administered the MAP and scored three children, while the second occupational therapist (supervisor) only scored their responses. A coefficient of 85% agreement was achieved.

The fact that the data for the present study and the Lane and Holdgrafer study were collected at the same time by the same evaluator helped to control for possible observer bias during the evaluation. The Lane and Holdgrafer study included both neurologically normal preterm children and neurologically suspicious preterm children. The evaluator did not know the neurological status of the children during the evaluation and, therefore, did not know which children were part of this study and which were part of the Lane and Holdgrafer study.

The MAP was administered in the same order and at the same place for all subjects.

The Measurement Instrument - The Miller Assessment for Preschoolers

The Miller Assessment for Preschoolers (MAP) was developed by an occupational therapist, Lucy Miller, to provide a comprehensive, reliable, and valid screening instrument for identifying children with moderate to severe preacademic problems (Miller, 1982). The MAP is intended for children ranging from 2 years 9 months to 5 years 8 months. It consists of 27 items measuring sensorimotor, cognitive, and combined abilities. Sensory and motor abilities are measured by: 1) Foundation index - assesses sense of position and movement, sense of touch and basic movements such as flexion, extension, rotation, and movement patterns; and 2) Coordination index - evaluates gross, fine, and oral motor coordination. Cognitive abilities are measured by: 1) Verbal index - measures language expression and comprehension, sequencing, association, and memory; and 2) Non-Verbal index - assesses memory, sequencing, visualization, and mental manipulation in activities not requiring verbal use. Combined abilities, which are measured by the Complex Task index, evaluate skills which involve sensory, motor, and cognitive abilities. In addition to these tests, a "behavior during testing assessment" measures the child's

attention, social interaction, and sensory reactivity. This form is completed after test administration.

The MAP takes 30 minutes to administer. The children receive a total score which classifies them as within normal limits, should be watched, or in need of further evaluation. In addition, they receive a score for each performance index which provides information about the child's abilities in different areas of development.

Reliability and validity information are provided in the manual. Inter-rater reliability coefficients ranged from 84 to 99%. Test-retest reliability ranges from 80 to 94% except for the Coordination index (72%). Content validity is presented through an specification table (which examines the content of the MAP in relation to the behaviors purportedly assessed), factor analysis, and the relationship between the tests and age-groups, and each test and index with the MAP total score. Criterion-related validity was determined by comparing the MAP with the Southern California Sensory Integration Tests, Denver Developmental Screening Test, Weschler Preschool and Primary Scale of Intelligence, and Illinois Test of Psycholinguistic Ability. Although significant correlations were found, the author recommends caution in the interpretation of the results due to the small sample size (N=30). Construct validity was established with 90 children with preacademic problems. The MAP correctly identified 75% of the sample. In addition, predictive validity studies conducted by Miller (1987, 1988) have shown that the MAP is a good instrument for predicting academic achievement. Daniels (1990) found that it discriminates between some diagnostic groups (children with speech-language, psychiatric, neurological, or motor problems).

Limitations of the MAP include long directions to be followed in some items. Children with language comprehension problems may have some difficulty in understanding some instructions. Some items, such as "stamp", may be difficult to score if the child's response is fast. As the assessments were videotaped in this study, the child's performance was verified later for more precise information. The MAP has not been normed in Canada and it is possible that Canadian children may have slight differences in development from American children. However, the MAP has been used in Canadian studies (e.g., Daniels, 1990).

In conclusion, although the MAP has not been used in studies of preterm infants, it appears to be a valid and reliable screening instrument and an useful test in detecting preacademic problems. According to Deloria (1985), the MAP is one of the few instruments for preschoolers which precisely follows the recommendations of the

Standards for Educational and Psychological Tests (APA, 1974).

Ethical Procedures

The parents of the preterm infants who agreed to the evaluation, signed a consent form (see appendix C) and retained a copy of the covering letter and the consent form. Confidentiality was ensured in this project by identifying the children only by code numbers. Their names or other information which might identify them were not reported.

Data Analysis

All variables were summarized using descriptive statistics. Additional information regarding birthweight, behavior during the assessment, number of singleton or multiple births, number of suspect children, and current maternal education was described.

A correlation matrix was done on the five MAP indices to determine if any were highly correlated and could be eliminated from the regression analysis to reduce the number of dependent variables.

Multiple regression analysis was used to test the correlation between gestational age and maternal education (independent variables) and each of the five performance indices and the total score of the MAP separately (dependent variables) and to determine which variable contributed most to the variance in the dependent variables.

Chi-square analysis was used to test the statistical significance of the relative risk associated with the two gestational age groups of infants (<32 weeks GA; 32-36 weeks GA) in the five performance indices and total score (normal; below normal). Chi-square analysis was also used to test the differences between the two maternal education groups (≤12 years of maternal education; >12 years of maternal education) in the five performance indices and total score (normal; below normal). As mentioned, the MAP uses a scoring system in which the item scores are classified as child within normal limits, should be watched or in need of further evaluation. For the chi-square analysis, the "within normal limits" classification was considered "normal". The "should be watched and in need of further evaluation" classifications were considered "below normal", as children scoring in these areas had performances below most children of their age and were likely to have future problems.

The alpha level of the tests was set at 0.05.

CHAPTER IV

RESULTS

CHARACTERISTICS OF SAMPLE

The sample consisted of 24 of the 45 preterm children who were classified as neurologically normal at 18 months of age in the Piper et al. (1989) study. Gender, gestational age, years of maternal education, mother's age at birth, and birth weight are reported in Table 1. There were more female (70.8%) than male infants in the sample despite the fact that the Piper et al. study had approximately equal number of males (n = 25) and females (n = 20). Gestational age ranged from 27 to 34 weeks with birth weight as low as 870 grams and as high as 3,390 grams. Three sets of twins were included. Seventeen subjects (70.8%) were enrolled in day care programs at least part of the day. The mean age at the time of the assessment was 4 years 6 months (SD = 3 months), ranging from 4.0 to 5.0 years. Approximately half of the mothers had an educational level greater than 12 years (58.3%). There was only one teenage mother in the sample (Table 1).

TEST RESULTS

1. MAP Scores

The subjects' mean scores by performance index and total score are reported in Table 2. As can be seen, most of the children, 14 of 23 (60.9%), are within the normal range for the total score. The frequencies of the MAP scores of the 24 infants are illustrated in Figure 1. Only two children (8.3%) were classified as "in need of further evaluation" and that was only for the Complex-Task index. One child had uncompleted scores in the Foundation, Verbal, and Total score performance indices due to behavioral problems. As the number of missing items in each of these indices exceeded one, the child's scores on these indices were not used as they were not considered reliable scores.

TABLE 1

Gender, Gestational Age, Years of Maternal Education, Maternal Age at Birth, and Birth Weight of Sample.

CHARACTERISTIC	N=24	MEAN (SD)
GENDER		—
MALE	7 (29.2%)	
FEMALE	17 (70.8%)	
GESTATIONAL AGE		31.3 (2.6)
27 WEEKS	2 (8.3%)	
28 WEEKS	4 (16.7%)	
29 WEEKS	2 (8.3%)	
30 WEEKS	1 (4.2%)	
32 WEEKS	6 (25.0%)	
33 WEEKS	1 (4.2%)	
34 WEEKS	8 (33.3%)	
MATERNAL EDUCATION		14 (2.1)
12 YEARS	10 (41.7%)	
13 YEARS	3 (12.5%)	
14 YEARS	1 (4.2%)	
15 YEARS	1 (4.2%)	
16 YEARS	7 (29.2%)	
18 YEARS	2 (8.3%)	
MOTHER'S AGE AT BIRTH		28.8 (4.5)
19 - 22 YEARS	3 (12.5%)	
23 - 27 YEARS	6 (25.0%)	
28 - 32 YEARS	10 (41.7%)	
33 - 36 YEARS	5 (20.8%)	
BIRTH WEIGHT		1785 (580)
750 - 1000 gm	2 (8.3%)	
1001 - 1500 gm	7 (29.2%)	
1501 - 2500 gm	14 (58.3%)	
> 2500 gm	1 (4.2%)	

TABLE 2

MAP Percentile Scores by Performance Index

CATEGORIES	MEAN (SD)	RANGE	Nº OF CHILDREN WITHIN NORMAL RANGE
FOUNDATION[a†]	44.1 (24.6)	(18-99)	20 (87.0%)
COORDINATION[b]	37.5 (24.8)	(8-99)	13 (54.2%)
VERBAL[c†]	46.2 (34.5)	(7-99)	11 (47.8%)
NON-VERBAL[d]	57.4 (29.9)	(14-99)	22 (91.7%)
COMPLEX-TASK[e]	39.6 (34.5)	(4-99)	14 (58.3%)
TOTAL SCORE[f†]	32.7 (19.2)	(7-74)	14 (60.9%)

Note. Performance within normal limits: [a] ≥ 29. [b] ≥ 33. [c] ≥ 48. [d] ≥ 30. [e] ≥ 31. [f] ≥ 26.
[†]N=23.

TABLE 3

Correlation Between Performance Indices of the MAP

	Foundation	Coordination	Verbal	Non-Verbal	Complex Task
Foundation	1				
Coordination	.12	1			
Verbal	-.24	.21	1		
Non-Verbal	.05	-.21	.13	1	
Complex Task	.37	.36	.33	.17	1

2. Correlation matrix for elimination of dependent variables

A correlation matrix was calculated to determine if there were any highly significant correlations among the dependent variables: Foundations, Coordination, Verbal, Non-Verbal, and Complex Task indices (see Table 3). The correlation coefficients ranged from .05 to .37 and were not significant. None of the indices could be excluded from the regression analyses.

3. Multiple regression analyses for correlation between independent and dependent variables.

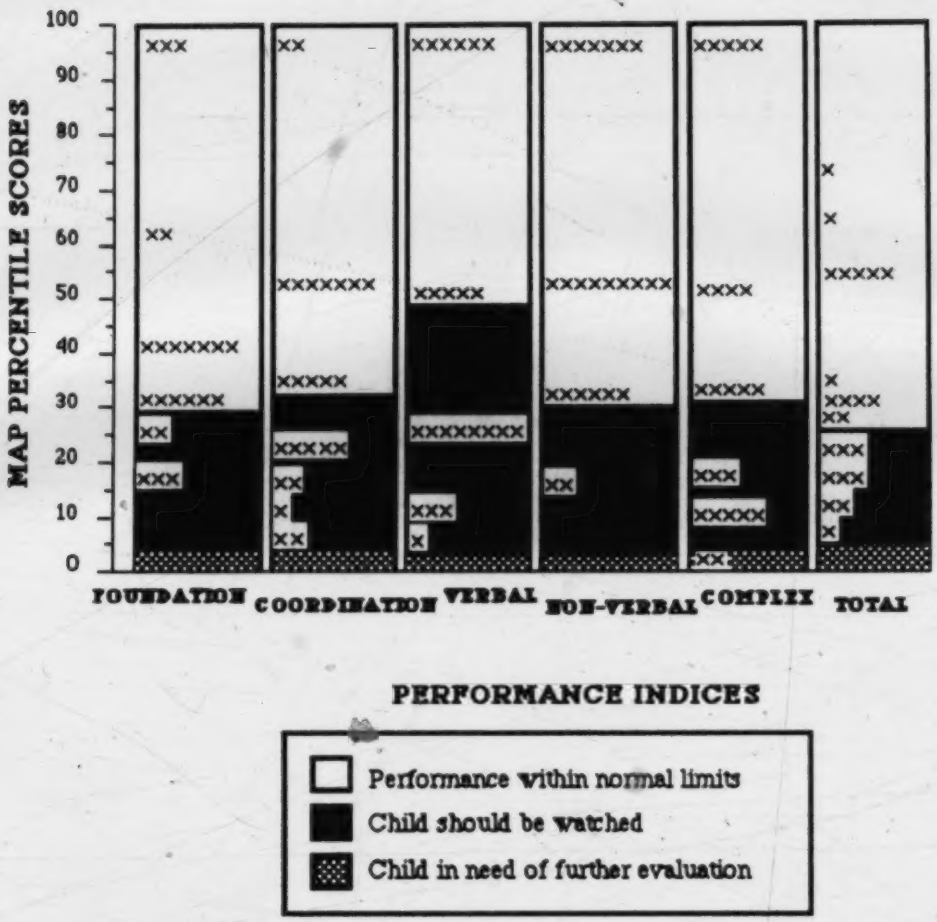
Multiple regression analysis was performed to determine if the independent variables together would be significantly correlated with the dependent variables. Maternal education and gestational age did not explain a significant amount of the variation in any performance index and the total score. Maternal education and gestational age accounted for 1% of the variance in Foundation scores, $F(2, 20) = 0.10$, $p = .91$); none of the variance in the Coordination scores, $F(2, 21) = 0.05$, $p = .95$; 6% of the variance in the Verbal scores, $F(2, 20) = 0.62$, $p = .55$; 17% of the variance in Non-Verbal scores, $F(2, 21) = 2.20$, $p = .14$; 7% of the variance in the Complex Task scores, $F(2, 21) = 0.81$, $p = .46$; and 8% of the variance in the Total scores, $F(2, 20) = 0.87$, $p = .43$.

When gestational age was examined alone as an independent variable, it explained a significant amount (17%) of the variation in the Non-Verbal scores, $F(1, 22) = 4.35$, $p = .05$. Gestational age was not significantly correlated with the other performance indices and the total score. The F tests varied from .02 to .77, with p values ranging from .38 to .96.

Maternal education alone did not explain a significant amount of the variation in any dependent measure. The F tests varied from 0 to .77, with p values ranging from .38 to .96.

FIGURE 1

Frequency of Performance Indices Scores



4. Chi-Square Analysis for Differences Between Gestational Age Groups and Maternal Education Groups.

Two gestational age groups (< 32 weeks; 32-36 weeks) were compared on the performance indices and total score (see Table 4). This cut-off is based on previous work reported in the literature (Largo et al., 1989; Piper, Byrne, & Pinnel, 1989; Piper, Darrah, & Byrne, 1989). The performance indices (Foundation, Coordination, Verbal, Non-Verbal, and Complex Task) and the total score were classified into two categories: normal performance and below normal performance, according to the cut-off established for each index in the MAP manual. A chi-square analysis was performed for each dependent measure. The observed frequencies varied significantly from the expected frequencies only in the Foundation index, $X^2(1, N = 23) = 6.47$, $p = .01$. All the children born at 32-36 weeks GA scored in the normal range on the Foundation test while 3 of the children born below 32 weeks GA (37.5%) scored below normal. The observed frequencies did not vary significantly from the expected frequencies for the other indices: Coordination $X^2(1, N = 24) = 1.14$, $p = .28$; Verbal $X^2(1, N = 23) = 1.06$, $p = .30$; Non-Verbal $X^2(1, N = 24) = 0.15$, $p = .70$; Complex-Task $X^2(1, N = 24) = 0.05$, $p = .83$; and total score $X^2(1, N = 23) = 1.81$, $p = .18$.

Two maternal education groups (12 years or less of education; above 12 years of education) were compared on the performance indices and the total score using the same classifications as described above for identifying normal and below normal groups. The observed frequencies did not vary significantly from the expected frequencies in any performance index score and total score (see Table 5). Chi-square results ranged from .05 to 1.56. Children born of more educated mothers did not do better on the MAP than children born of less educated mothers.

TABLE 4

Comparison of Gestational Age Groups by Performance Indices Categories

PERFORMANCE INDICES	GESTATIONAL AGE GROUPS	
	< 32 WKS (n=9)[A]	32-36 WKS (n=15)
FOUNDATION[†]		
NORMAL	5 (62.5%)	15 (100%)
BELOW NORMAL	3 (37.5%)	0 (0%)
COORDINATION		
NORMAL	4 (44.4%)	10 (66.7%)
BELOW NORMAL	5 (55.6%)	5 (33.3%)
VERBAL		
NORMAL	3 (37.5%)	9 (60%)
BELOW NORMAL	5 (62.5%)	6 (40%)
NON-VERBAL		
NORMAL	8 (88.9%)	14 (93.3%)
BELOW NORMAL	1 (11.1%)	1 (6.7%)
COMPLEX-TASK		
NORMAL	5 (55.6%)	9 (60%)
BELOW NORMAL	4 (44.4%)	6 (40%)
TOTAL SCORE		
NORMAL	3 (37.5%)	10 (66.7%)
BELOW NORMAL	5 (62.5%)	5 (33.3%)

Note. [A] = n varies from 8 to 9.

† significant

df = 1

TABLE 5

Comparison of Maternal Education Groups by Performance Indices Categories

PERFORMANCE INDICES	MATERNAL EDUCATION GROUPS	
	12 YEARS OR LESS (n = 10)[a]	ABOVE 12 YEARS (n = 14)
FOUNDATION		
NORMAL	8 (88.9%)	12 (85.7%)
BELOW NORMAL	1 (11.1%)	2 (14.3%)
COORDINATION		
NORMAL	7 (70%)	7 (50%)
BELOW NORMAL	3 (30%)	7 (50%)
VERBAL		
NORMAL	5 (55.6%)	7 (50%)
BELOW NORMAL	4 (44.4%)	7 (50%)
NON-VERBAL		
NORMAL	10 (100%)	12 (91.7%)
BELOW NORMAL	0 (0%)	2 (8.3%)
COMPLEX-TASK		
NORMAL	5 (50%)	9 (58.3%)
BELOW NORMAL	5 (50%)	5 (41.7%)
TOTAL SCORE		
NORMAL	4 (44.4%)	9 (64.3%)
BELOW NORMAL	5 (55.6%)	5 (35.7%)

Note. [a] = n varies from 9 to 10.

df = 1

CHAPTER V

DISCUSSION

DEVELOPMENTAL OUTCOME AS MEASURED BY THE MAP

The present study has shown that 14 (60.9%) of 23 children born prematurely were functioning within the normal range according to the MAP total score. This proportion is similar to that reported in other studies of normal preterm infants using other developmental measures (Drillien, 1972; Stewart et al., 1989; Vohr et al., 1988).

On the five performance indices, 54 to 92% of the children were doing well, except on the Verbal index where only 47.8% ($n = 11$) were within the normal range. English was not the first language for three of the children who scored below average and this may have affected their scores. Miller (1982) reported that the number of children who did not speak English fluently was small in the normative sample. Thus, caution is suggested when interpreting the scores of these children as they may not represent adequately the performance of this group. Exclusion of these three children from the Verbal index would increase the proportion of children scoring in the normal range on this index to 55%, making it more similar to the percentages on the other indices.

As part of the Lane and Holdgrafer study, the language development of 18 of the subjects was assessed and 17 (94.4%) of these children were performing within normal limits (G. Holdgrafer, personal communication, January 29, 1991). Ten children were classified the same on both the MAP and the measures used in the Holdgrafer and Lane study (9 normal, 1 below normal). There were disagreements between the MAP and the Holdgrafer and Lane classifications on the remaining 8 children. Differences between the results in the two studies appear to be due to the measurement instruments used. The MAP is a screening instrument and is not designed to provide an indepth assessment of all aspects of language. Several tools were used to evaluate expressive and receptive aspects of the children's language performance in the Lane and Holdgrafer study while the MAP had only four subtests. Miller (1982) reported that the fewer the items in each performance index, the less reliable the final score. Although reliability and validity information in the manual is within acceptable limits, when comparing the Verbal index with the Illinois Test of Psycholinguistic Ability for construct validity, the correlation was low (.14). Thus, caution should be used when interpreting the verbal scores in this study and in

occupational therapy practice. Also, the items used for the language evaluation in the MAP assess functions such as memory and sequencing, in addition to language abilities. Possible dysfunction in memory and sequencing areas might have decreased the verbal score and these areas should be further assessed.

On the other MAP indices, two children were in need of further evaluation and that was on the Complex-Task index. This index measures the child's combined sensory, motor, and cognitive abilities and may be more sensitive than the other indices in measuring the integration of these senses. As this is a complex function, one would expect some preterm infants to have more difficulty in the execution of tasks on this index.

Behavior during testing was assessed in the areas of sensory reactivity, social interaction, and attention. Of the 24 children, 2 (8.3%) presented moderate dysfunction in the area of sensory reactivity, becoming uneasy when touched; one of the two also presented moderate dysfunction in the area of social interaction. Three (12.5%) other children showed severe and moderate dysfunction in the area of social interaction, refusing to go along with examiner and being quite demanding during the examination; one of these children also manifested moderate dysfunction in the attention area, needing rewards quickly to proceed to next task and being easily diverted during testing. From this group of five children, two had low total scores ("child should be watched"). One of these two subjects' total score and 4 performance indices scores were below average. No relationship was observed between the other children who presented behavioral problems and their scores.

The proportion of subjects with attention deficits is close to that reported in Li, Sauve, and Creighton's study (1990) which found that 2 to 8% of their preterm children had inattention, hyperactivity or distractibility at 3-4 years of age. On the other hand, this study's results are lower in comparison to Astbury, Orgill, and Bajuk's study (1987), which reported the same problems, as well as impulsivity, for 40% of their preterm subjects. Astbury and associates mentioned that their results were also higher than the 3% estimate provided by the American Psychiatric Association (1980). Thus, in general, this study supports the low rate of behavioral problems in preschool preterm children reported in the literature.

GESTATIONAL AGE

The hypothesized relationship between gestational age and the Verbal index was not found in this study. This result does not support the Vohr et al. (1988) study

which found that normal preterm infants were significantly delayed in language ability at 2 years of age. The differences between the present and Vohr et al. (1988) study seem to be attributable to different measurement instruments and age at evaluation. It is also possible that normal preterm infants at younger ages have language deficits which disappear when preterm infant development catches up with "normal" development (Ungerer & Sigman, 1983).

A significant correlation was found between gestational age and the Non-Verbal score. This finding was statistically significant and was not due to chance alone as it accounted for a high percent (17%) of the variance. This result is supported by Towen's theory of development (1980) which proposes that the extrauterine environment can enhance or retard preterm development. Although the Non-Verbal index measures functions such as sequencing, memory, and performance of mental manipulation, the five sub-tests (Puzzle, Figure-Ground, Object Memory, Block Tapping, and Sequencing) contain a heavy visualization component. This function is reported to be still developing until the last month of gestation (Friedman, Jacobs, & Werthman, 1981). It is possible that the children who were born at a younger GA might have their visual ability negatively affected by the extrauterine environment. Although some authors (Ramey, Zeskind, & Hunter, 1981) argue that the lack of stimulatory environment may jeopardize these infants' development, others (Short-DeGraff, 1988) report that the stimulus bombardment in the neonatal intensive care unit (NICU) may not be appropriate in terms of sensory experiences. Sehnal and Palmeri (1989) report that the environment of the NICU may be overstimulating in part due to the bright lights required for the services. Both conditions, lack of stimulation and overstimulation, are seen as not providing the normal course of development as it would be experienced in uterus. Van Holf-van Duin and Mohn (1984) report that neurons of the visual pathway during fetal life are still immature and that they fully develop by nine months of age. Thus, it is possible that if the immature system of the preterm infant is not provided with an adequate setting for development, non-verbal aspects may be affected. However, it must be remembered that only two of the children had below average Non-Verbal scores.

When gestational age was examined as a nominal variable with groups of younger (<32 weeks) and older (32-36 weeks) preterm infants, the results were different. While all of the children born between 32-36 weeks GA were in the normal range for the Foundation index, 62.5% of the children born below 32 weeks GA were in this category. This result was statistically significant. For the other indices, there

were no significant differences between the expected and observed frequencies.

The significant difference between the two gestational age groups on the Foundation index was unexpected. As mentioned before, the Foundation index measures the child's sense of position and movement, tactile perception, and basic components of movement. All children who were born below 32 weeks had at least two items with below average performance in the area of sense of position and movement, and 63.5% had one item related to tactile perception with below average performance. It appears that the major areas affected in the Foundation index were position and movement. Again, according to Towen's theory of development (1980), it is possible that a non-optimal extrauterine environment might have affected development in this area. In the seventh month of fetal development, some functions such as muscle tone and behavioral reflexes are still developing (Short-DeGraff, 1988; Williams, 1983). As these infants still do not have adequate musculature and poor motor control to stimulate themselves, it is possible that this period of inactivity may affect their later development. Some authors (Kramer & Pierpoint, 1976) even suggest intervention techniques such as rocking and water beds to compensate for the hypothesized sensory deprivation. As well, the additional equipment frequently attached to these infants in NICU may prevent parents from carrying and stimulating their babies.

MATERNAL EDUCATION

The hypothesized relationship of maternal education and the Complex-Task and Non-Verbal indices was not found in this study. This finding does not support the literature which reported a significant correlation between low maternal education and perceptuo-motor and cognitive problems (Blackman et al., 1987; Klein et al., 1985; Rickards et al., 1988; Sameroff, 1986; Scott, 1987). Possible explanations for the discrepancy between these studies and the present one might be the neurological status of the sample, age at evaluation, different areas of development investigated, and the range of maternal education. In this study, only children who were diagnosed neurologically normal were included in the sample. In the other studies, some did not mention the neurological status of the preterm infants and others included children with medical abnormalities. It is possible that low maternal education has less effect on the development of preterm children without neurological problems, and that its effect is observed when the infant's medical problems make him/her more vulnerable to environmental effects. As well, the majority of the studies mentioned above were

conducted with children above five years of age. This age may be the minimum age at which the influence of maternal education on child's development becomes apparent. It is also possible that the areas most affected by maternal education are the child's school achievement and IQ, as mentioned in some reports reviewed previously. These areas were not investigated in this project. The fact that all of the mothers had a minimum of 12 years of education might reflect a bias in the sample towards a higher level of maternal education. It is possible that 12 years of education may be sufficient to prepare the mothers for raising their children. Thus, this fact might have also influenced the lack of relationship between maternal education and the children's outcome.

When maternal education was used as a nominal variable in a chi-square analysis (>12 years of education and ≤12 years of education), no significant differences were found between the expected and observed frequencies. This finding adds some support to the results of the multiple regression analysis, which found no relationship between maternal education and the total score and performance indices. However, there are some limitations concerning the chi-square analysis. According to Norman and Streiner (1986), for the chi-square, there should be at least 5 subjects in each cell for the expected frequency or the results are considered inaccurate. In this study, all the performance indices and the total score have some cells with expected frequencies below 5. Thus, the results should be interpreted with caution.

The fourth hypothesized relationship of this study was that gestational age and maternal education would be significantly correlated with the Complex Task, Coordination, Verbal, and Non-Verbal indices of the MAP. This result was not found. This study failed to show a significant relationship between the two independent variables, when treated as continuous data, and each of the 5 performance indices and the total score.

LIMITATIONS

The high prevalence of female (70.8%) to male infants in this sample is unusual. The original sample (Piper et al., 1989) included 44.5% female infants. In other follow-up studies (Calame et al., 1986; Klein et al, 1989; Largo et al., 1990; Ungerer & Sigman, 1983), the ratio of females to males was usually from 38 to 53%. This finding raises the question of whether the disproportionate number of girls could have biased the results.

Some authors reported significant differences between male and female infants

(Grigoroiu-Serbanescu, 1984; Rubin et al, 1973). These authors found that females were doing better than males in school placement. Interestingly, the results of this study showed that 68.8% of females were performing within normal range while 57.2% of males were classified in this area. It is possible that this study may be evaluating a sample which includes a predominantly lower risk group (female). However, other authors (Caputo, Goldstein, & Taub, 1981; Cohen & Parmelee, 1983) have reported no significant differences between males and females. Until further investigation is done in this area, no assumptions can be made concerning the effect of a possible gender bias on the results. A more equal ratio of male and female infants in future studies would eliminate gender as a possible confounding variable.

The results should be taken with caution prior to replication due to a number of limitations including a small sample size. Particularly in the chi-square analysis, there were only 8 subjects in the gestational age group "below 32 weeks". A small change in the number of subjects in the "normal" and "below normal" groups would make a difference in the results. In addition, there were three sets of twins in this study. It is possible that the presence of twins who had the same GA but different birth weights and mothers with the same level of education may have contributed to the failure of this study to find the predicted correlation between gestational age and maternal education and the dependent variables. However, when the twins were excluded from the data analysis of the study, the only significant correlation found was between gestational age and the Non-Verbal index ($F(1, 16) = 6.04$, $p = .02$). Excluding the twins did not alter the results. Other limitations of the study include no control group of neurologically suspect children or normally developing children (MAP normative data allows some comparison to normally developing children).

CHAPTER VI

SUMMARY AND CONCLUSIONS

Few studies have examined the development of preterm children who were diagnosed neurologically normal in the first years of life (Drillien, 1972; Stewart et al., 1989; Vohr et al., 1988). This study investigated the outcome of preterm infants considered neurologically normal at 18 months of age in order to determine their developmental outcome at 4 years of age, and to examine the relationship of biological/environmental factor on outcome in the absence of medical abnormalities. A considerable percentage of the children in this study had MAP scores which indicated developmental delays. It would appear that a neurologically normal status at 18 months does not mean that these children's development will keep pace with their peers. Early identification of these children is important due to the adverse consequences, such as emotional problems associated with school failure and reduced effectiveness of therapeutic treatment at later ages (Miller, 1982).

Professionals, such as occupational therapists, who work in early intervention and in NICU should pay attention especially to the area of position and movement and areas which involve a combination of sensory, motor, and cognitive abilities. Soltesz and Brockway (1989) report that therapeutic handling helps the infant to experience sensorimotor stimulation which improves the child's body schema. They mention that rolling, carrying, lifting, and place the infant in side-lying, among others, are beneficial techniques to improve coordination, muscle tone, and increase flexor patterns. Sehnal and Palmeri (1989) suggest environmental adaptations in NICU to facilitate infants' responses which therapists might consider. Some adaptations include placing toys in the child's line of vision in isolette and avoiding loud noises and abrupt movements. According to these authors, procedures such as these, would help the infant to decrease hypersensitivity to movement and sounds and increase visual responsiveness.

This study failed to demonstrate a significant relationship between gestational age and maternal education, and the five performance indices and the total score of the MAP. However, a significant correlation was found between gestational age and decreased performance on the Foundation index. The Foundation index measures the child's sense of position, movement and touch, and movement patterns such as flexion, extension, and rotation. According to this study, preterm infants who were

born at less than 32 weeks GA may be at-risk in areas requiring abilities involving tactile and kinesthetic activities. Ayres (1972) reported that children who have problems in integrating these sensations do not have a good perception of body parts and their movements. Consequently, they may have difficulty doing some activities such as manipulation of objects, positioning in seats, moving body parts freely and protecting from falling. Follow-up programs for infants less than 32 weeks GA would help to detect possible problems in these areas as soon as they emerged and provide appropriate intervention.

The significant relationship found between gestational age and low scores in the Non-Verbal index also provides useful information. If the development of the very premature infants can be affected by the extrauterine environment, the efficacy of early intervention techniques needs closer investigation as it could provide positive results for this population.

This study failed to show a significant relationship between gestational age and the other performance indices and the total score. No significant association was found between maternal education and the performance indices and the total score. Although no relationship is reported for these variables, it is not possible to affirm that there is no relationship between them due to the small sample size. The study needs to be replicated with a larger sample. It is possible that the lack of relationship between maternal education and the dependent variables may have been due to factors such as, a sample of neurologically normal infants who may not be affected by maternal education level, the limited range of maternal education, age at evaluation, and the areas of development chosen for investigation in the present study.

Future Directions

Replication of this study with a larger sample size, and consequently, a wider range in the level of maternal education, is needed to confirm the results of this study. As well, the inclusion of more environmental and biological factors would permit a better analysis of the effects of both variables in child development. Further follow-up as the children in this study start school will provide information about later outcome of neurologically normal preterm infants and will allow examination of the predictive validity of the MAP with this population. Finally, the use of more indepth measures in the areas in which performance was low (non-verbal, position and movement abilities) would provide additional information as to whether these areas are the ones most likely to be affected by gestational age.

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APPENDICES

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Faculty of Rehabilitation Medicine
Office of the Dean

Canada T6G 2G4

316 Corbett Hall, Telephone (403) 492-2903 / 5991
Fax (403) 492-1626

Appendix A

EVALUATION OF LANGUAGE, PERCEPTUAL MOTOR SKILLS, AND BEHAVIOR IN 3-4 YEAR OLD CHILDREN BORN PREMATURE

Dear

We have received your name from Annette Kudje, and thank you for allowing us to contact you in regard to our current project. We are interested in learning more about how children born before their 37th week of gestation are developing. We would like to evaluate many of your childs skills, including language, balance, perception, fine motor, and gross motor, as well as your childs' behavior as you see it. If you agree to participate in this project you will be given a questionnaire to fill out pertaining to your childs' behavior and development, and you and your child will be asked to come into the University (at a time most convenient for you) for evaluations of the skills described above. The questionnaire will take about 15 minutes to complete and it can be done either before your evaluation appointment or while your child is being evaluated. The evaluation will be videotaped and will take 1-1 1/2 hours of your time. The videotapes will be used for purposes of research only. They will be maintained in an archive. An ID number will be used to identify the tapes rather than your child's name.

The results of the evaluations will be used by us to increase our understanding of the development of premature children. Should we identify any specific problems in your child, we would be glad to discuss these with you and refer you to appropriate sources for help if it is warranted, and if you so wish. We cannot provide follow up within the limits of the current study.

Your participation is entirely voluntary and you are free to withdraw your child from this project at any time without affecting any current or future care your child may need. All information gathered will be kept confidential and no publication or presentation of this material will disclose the identity of yourself or your child.

As we discussed on the phone, your appointment has been scheduled for _____. The session will take approximately 90 minutes. We will do the evaluation at the Garneau Professional Building. The address of this building is 11044-82nd Ave., and it is just one block west of campus. There is parking in an underground garage, and we will sign the parking ticket to provide you with free parking.

If you would like more information prior to that time, or have any questions at any time, please feel free to call one of us at the phone numbers on the next page. Thank you again for agreeing to participate in this project.

Sincerely,

Shelly J. Lane, PhD
Assistant Professor,
Occupational Therapy

Gary Holdgrafer, PhD
Chair and Professor
Speech Pathology and Audiology

Shelly J. Lane, PhD
492-2499
(you may call this number and leave a messege; Shelly will get back to you)

Carla Attanasio
Graduate Assistant, Occupational Therapy
431-1906

Gary Holdgrafer, PhD
492-5980

Jacquie Forwards
Graduate Assistant, Speech Pathology and Audiology
435-4786

Appendix B

University of Alberta
Edmonton
Canada T6G 2G4

Faculty of Rehabilitation Medicine
Office of the Dean
316 Corbett Hall, Telephone (403) 492-2903 / 5991
Fax (403) 492-1626

CONSENT FORM

EVALUATION OF LANGUAGE, PERCEPTUAL MOTOR SKILLS, AND BEHAVIOR IN 3-4 YEAR OLD CHILDREN BORN PREMATURE

I have read and kept for my files the cover letter explaining the project designed to evaluate many skills and behavior in my child. I understand that the objective of this project is to gain a better understanding of the development of children born prematurely.

I understand that I will be given a behavioral and developmental questionnaire to fill out and return to the researchers, and that I will be asked to attend an evaluation session at the University with my child. This evaluation will take 1 - 1 1/2 hours to complete and will look at the development of my child in the areas of language, balance, perception, and gross and fine motor skills. I understand that this session will be videotaped and that these tapes will be kept in an archive, but will be used only for research purposes. An identification number, rather than my child's name, will be used to identify the tapes.

I understand that the information gathered will be kept confidential and no publication or presentation that may come as a result of this study will disclose the identity of my child or myself.

I understand that if the researchers identify problems in my child they will discuss these with me, and will refer us to the appropriate source for follow up if I so desire. I understand that they cannot provide follow up within this project.

I also understand that my participation is entirely voluntary and that I may withdraw my child from this project at any time without affecting any present or future treatment my child may require.

Before signing this form I have had all my questions answered to my satisfaction, but I also know that if I have any additional questions I may contact either Dr. Shelly J. Lane (492-7245) or Dr. Gary Holdgrafer (492- 5980) at any time.

_____ _____

signature date

_____

witness

APPENDIX C

Informed Consent Form for Preterm Study

THE RELATIONSHIP OF ENVIRONMENTAL/BIOLOGICAL FACTORS AND THE SENSORIMOTOR AND LANGUAGE DEVELOPMENT OF PRETERM CHILDREN

I have read the letter explaining the project. I understand that the purpose of this study is to better understand the development of children who are born early.

I understand that

1- I will complete a short questionnaire;

2- I will bring my child to the University for 40 minutes of testing. This test will look at his/her abilities in the areas of language, balance, perception, motor skills and behavior;

3- this session will be videotaped. These tapes will be marked with a number, instead of the child's name;

4- the information collected will be kept confidential. When findings are presented my child's or my name will not be given;

5- if the researcher finds problems in my child she will discuss this with me. She will suggest someone to contact if I so wish. I understand that she cannot provide follow up within this project.

6- my participation is voluntary. I may withdraw my child from this project at any time without causing any problem for my child.

Before signing this form my questions were all answered. I know that if I have any more questions I may call either Carla Attanasio (431-1906) or Joyce Magill-Evans (492-0402) at any time.

NAME (please print):_____

SIGNATURE:_____

DATE:_____

WITNESS:_____

RESEARCH:_____

APPENDIX D

THE RELATIONSHIP OF ENVIRONMENTAL/BIOLOGICAL FACTORS AND THE SENSORIMOTOR AND LANGUAGE DEVELOPMENT OF PRETERM CHILDREN.

Dear

We have received your name from Annette Kudja (research assistant). Thank you for allowing us to contact you. The purpose of this study is to learn about how children who are born early develop. We are interested in children ages three to four years.

We would like to see your child's ability to:

1. talk and understand commands (language);
2. move their arms and legs (motor skills) and balance;
3. do puzzles and find objects hidden in pictures (perception);
4. pay attention;

We would also ask you to answer some written questions about your education and if your child has been in day care.

The testing would be done by an occupational therapist at the university at a time of day that suits you. It would last 40 minutes and the children usually enjoy it. We will videotape the testing. The videotape and questionnaire will not have your child's name on it, only a number. When the findings of the study are presented at meetings or in articles, your name will not be given. The tapes will only be used for research and kept in a locked area and remain confidential.

If we find that your child has any problems, we will tell you and suggest someone you can contact if you wish. We cannot provide treatment as part of this study.

Being part of this study is completely voluntary. You may withdraw from the study at any time by telling us that you do not want to continue. This will not cause any problems for you or your child.

We will do the testing at the Garneau Professional Building. The address is 11044-82nd Ave. We will meet you on the fourth floor at the elevator. There is underground parking. We will pay for the parking.

If you have any questions, please feel free to call us at the phone numbers below. Thank you again for agreeing to participate in this project. The results of this study may help other children.

Sincerely,

Carla Soares Attanasio
Graduate Student,
Occupational Therapy
(431-1906)

Joyce Magill-Evans, PhD
Assistant Professor/Thesis Supervisor
Occupational Therapy
(492-0402)

APPENDIX E

ADDITIONAL INFORMATION

1- Mother's level of education when the child was born:

_____.

2- Mother's highest level of education: _____

3- Mother's years of education: _____

4- Has your child ever been enroled in a day care, day home or play school?

_____

If so, when and for how long?_____

APPENDIX F

Letter to the parents

Dear Mrs. _____,

Thank you very much for your cooperation in bringing ____ for evaluation last year as part of our study "The Relationship Between Biological/Environmental Factors and Sensorimotor and Language Development". In the beginning of the study, we sent you a letter explaining the objectives of the project and promised that we would inform you about any concerns which our evaluation found. We have completed our analysis of the results. According to the test we used, _____ is doing well in the areas of language, perception, balance and gross and fine motor skills. However, she was below average on some tests which evaluated the integration of sensory and motor abilities. We feel that _____ may need to be evaluated by another professional in order to better analyze her abilities as measured by other tests of these abilities. The test we used is only designed to identify children who need further evaluation. As she did well in all other areas, it is possible that her below average scores are due to a long and tiring test. If you have concerns about _____'s performance in these areas, we suggest that you contact your doctor so that he/she can refer _____ to an occupational therapist, who is able to evaluate _____'s skills in these areas. If you have any questions or concerns about our results, please contact me at 432-1134. We would like to thank you again for your participation and wish you and _____ all the best in the future.

Sincerely,

Carla Soares Attanasio
Graduate Student, Occupational Therapy